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# Autonomous Underwater Vehicle (AUV) Fest 2007 Summary

Phillip J. Bernstein  
NSWC PC, Code HS14  
110 Vernon Ave.  
Panama City Beach, FL 32407 USA

**Abstract-** This paper will summarize the results of AUV Fest 2007. AUV Fest 2007 was hosted by the Naval Surface Warfare Center Panama City (NSWC PC) at the Naval Support Activity Panama City (NSA PC). This Sea Trial Project and FORCENet Enabling Demonstration was the largest in-water demonstration of unmanned underwater, surface, air and ground vehicles ever conducted. The event was sponsored by the Office of Naval Research (ONR). Six previous AUV Fests were conducted since the events were initiated in 1997.

## I. INTRODUCTION

Autonomous Underwater Vehicle Fest 2007 was hosted 4-15 June 2007 by the Naval Surface Warfare Center Panama City (NSWC PC) at the Naval Support Activity Panama City (NSA PC). This Sea Trial Project and FORCENET Enabling demonstration was the largest unmanned systems demonstration every attempted.



Figure 1: AUV Fest Systems

The goals of AUV Fests are to:

- Expose the operational Navy to the developing capabilities of AUVs by demonstrating diverse, emerging technologies in a common, at-sea environment
- Expose the AUV research community to the needs of the operational Navy
- Expose industry to Navy needs and emerging AUV-related technologies
- Characterize the performance of candidate underwater navigation and acoustic communication systems in common, measured ocean environments

The primary ONR objectives for AUV Fest 2007 were to demonstrate AUV systems emerging from the Organic Mine Countermeasures and Autonomous Operations Future Naval Capabilities Programs in support of Mine Countermeasure missions and demonstrate interoperable communications of data and mission status among various unmanned vehicle systems. Emphasis was on large area coverage, Buried Mine Hunting (BMH) and ocean monitoring.

In conjunction with AUV Fest 2007, The Technology Cooperation Panel (TTCP) conducted the Mongoose 07 Trial. The focus of the TTCP is to leverage research being conducted in the five TTCP countries Australia, Canada, New Zealand, United Kingdom and the United States. The goals of the Mongoose 07 Trial were to demonstrate coalition operations performing mine countermeasures operations.

AUV Fest 2007 also enabled vehicle and technology developers to demonstrate the next generation of unmanned system capabilities focused on the needs of today's Fleet operator.

Based on the feedback from AUV Fest sponsors, vehicle demonstration teams and fleet observers, all goals and objectives of AUV Fest 2007 were met. Participants reported that design of AUV Fest as a demonstration venue and not as a competition between system, greatly fostered collaboration and cooperation among unmanned systems researchers.

## II. AUV FEST 2007 DEMONSTRATIONS

AUV Fest 2007 demonstrations were grouped into two areas, tactical play and experimentation. The tactical play portions of the demonstration were designed to showcase the more mature unmanned systems technologies. These demonstrations were

orchestrated to simulate use in a naval fleet exercise. The experimentation portion of the fest was much less constrained and was designed to allow participants to novel unmanned systems capabilities that are still in early phases of development.

### Tactical Play

The tactical play was focused on three areas, wide area search, buried mine hunting and coalition operations.

The wide area search demonstrations were designed to demonstrate the capabilities of unmanned systems to search large areas without the need for continuous operator intervention. The ability to perform wide area search is a key driver in the Navy's future Sea Base concepts. Three key areas were explored during AUV Fest 2007 in support of this initiative, unmanned surface vehicles, moving baseline unmanned underwater vehicle (UUV) navigation and multi-vehicle operations. Unmanned surface vehicles provide the advantage of high speed transits and long range operations due to their large fuel capacity. The moving baseline navigation provides the ability for underwater vehicles to conduct extended missions without the need to surface for navigation updates. The multi-vehicle operations permit groups of unmanned systems to conduct coordinated surveys thereby covering much more area than a single vehicle could in the same time period.

The second portion of the tactical play was focused on technologies designed to detect buried objects. While the ability to detect and identify proud objects is fairly mature, detecting small buried objects is still a maturing science. Two primary approaches were demonstrated in this area, acoustic only sensors and combined acoustic and magnetic sensor suites. The

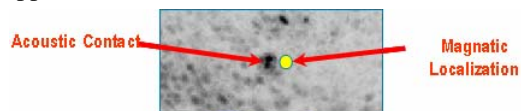


Figure 2: Example of combined sensor suite data fusion.

acoustic sensors focused on mid-frequency synthetic aperture sonars. Unlike the higher frequency sonars used for bottom imaging, these lower frequency sensors are designed to maximize penetration into bottom sediment. The

combined acoustic and magnetic sensor suites rely on data fusion between the sensors to detect buried objects.

The third portion of the tactical play was coalition operations. These demonstrations were designed to highlight interoperability between unmanned systems from different countries. As more and more countries integrate unmanned systems into their naval capabilities, the ability for these unmanned systems to operate together will take on increased value.

### Experimentation

The experimentation portion of AUV Fest allowed less mature systems to demonstrate their capabilities in a less restrictive environment than the tactical play. Experimentation included, but were not limited to multi-vehicle collaborative operations, biologically inspired propulsion systems, autonomous obstacle avoidance, hull search technologies and underwater networking.

Multi-vehicle collaborative operations included groups of UUVs and coordinated operations between Unmanned Aerial Vehicles, Unmanned Surface Vehicles and Unmanned Ground Vehicles. This experimentation demonstrated the ability of vehicles to work as a team towards a common goal.

Innovative propulsion designs were demonstrated on several vehicles. Vehicles demonstrated the ability to hover and perform detailed searches of a pier wall through the use of coordinated thruster and primary propeller control. Biologically inspired vehicles demonstrated the ability to swim like a turtle using actuators designed like flippers. This vehicle could then transition to crawling mode as it approached the beach.

Vehicles demonstrated autonomous obstacle avoidance both with and without apriori knowledge of the obstruction. This behavior is critical to the success of unmanned systems in long endurance missions.

Several UUVs demonstrated the ability to search along the bottom of a hull. This is a very challenging behavior due to the changing currents around a ship's hull and the unknown protrusions commonly found along a ship's hull.

Finally advanced underwater communications were demonstrated by many of the vehicles. Common types of communications were relay of data found during a mission, communications to other UUVs to aid with group formations and retasking of UUVs that were underway.



Figure 3: Nekton Ranger UUV with Flipper Propulsion

## III. AUV FEST 2007 HIGHLIGHTS

AUV Fest had several significant highlights during the two week event.

Significant highlights include:

- over 700 hours of unmanned systems operations,
- as many as 17 unmanned systems operating simultaneously
- over 500 participants with more than 75 technologies

- Over 150 unmanned systems missions with only two canceled due to vehicle problems.

#### IV. CONCLUSION

AUV Fest 2007 was an unqualified success based on feedback received from all sponsors and participants. AUV Fest 2007 demonstrated that the maturity and reliability of unmanned systems has reached the point where these systems are now valuable research tools. There are several tangible benefits from an event like this, but perhaps the greatest benefits are the intangibles. No other venue provides this type of opportunity for the world's leading researchers in unmanned systems the ability to collaborate with peers in their field while performing coordinated experimentation.

#### ACKNOWLEDGMENT

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